

Media communiqué

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Japanese material investigation technique applied to historic swords

Japanese polishing process reveals the secrets of European swordsmiths

Japanese swords are considered to be the non plus ultra of the swordsmith's art. They were (and still are) made of steel folded several thousand times. In contrast to this, ancient European swords were apparently made with only a dozen or so layers. Is this actually true or in fact a false impression, a myth? The answer to this and other questions about European and Japanese sword manufacturing were supplied by the archeologist Stefan Maeder during a recent lecture held at Empa.

The art of Japanese sword making is as famous as the Samurai warriors who used them. The myths surrounding those well armed nobles have helped feed the legend that Japanese sword blades were the best in the world, despite the fact that a proper comparison has never been made. In fact little is actually known about the original condition of European swords dating from early times. "Swords from archaeological excavations are normally nothing but lumps of rust," says sword researcher and kendo exponent Stefan Maeder. The rusting remains do not allow investigators to draw reliable conclusions regarding the way they were manufactured or the properties of the materials out of which they were made, according to Maeder, who has been studying the technological and cultural aspects of sword manufacturing in Europe and Japan for more than a decade. The Assistant Professor at Kokugakuin University in Tokyo gave his talk in Duebendorf at the invitation of Empa's Center for Cultural Property Analytics

Kantei – a Japanese method of evaluating the quality of swords

"In the past in western archaeology polishing and grinding techniques used have hardly been used to study swords," says Maeder. Quite the opposite in Japan, where over the centuries a method of evaluating sword quality has been developed, known as "kantei". This is based on the grinding and polishing of the blade, ever finer grained grindstones being used in conjunction with a basic water bath. As the process continues, it becomes slowly possible to infer more and more information about the material properties and the manufacture of the blade from its surface. By reading the texture of the metal and the transition line, Japanese experts can determine from which era a blade originates and in which smithy it was manufactured – even down to which individual swordsmith did the work! Kantei, however, is not a quick process and applying it over the complete surface of a blade takes

two to three weeks. It also needs a fine touch. "During the polishing process one learns to recognize the subtleties and intricacies of a sword blade," says Maeder. So far no one has attempted to localize the smithies where European swords were manufactured by studying the surface of their blades, according to Maeder. "But there is no reason why here too one couldn't set up a system for classifying swords like that in Japan."

The kantei method is a predecessor to modern metallurgical techniques. It is in fact superior to modern tests because it involves studying the whole of the blade surface, while in contrast modern metallographic techniques rely on testing a small sample of metal cut out of the test object. Despite this, kantei alone cannot pinpoint the origin of a European sword, since little is known about the swordsmiths themselves. Modern methods could, however, be employed to supplement the kantei technique and bridge this gap. Since the 1980's Empa has been conducting metallographic studies – for example the oldest European sword known was investigated by the institution to determine its iron content. This sword dates from the 8th century BC and was discovered in a funeral pyre excavated in Singen, Germany. "We compare the chemical composition of the iron in the sword to that of various iron deposits," says Marianne Senn, Empa archaeo-metallurgical expert and Head of the Center for Cultural Property Analytics. "This allows us to determine from where the iron which was used to manufacture the sword originated. The geographical determination makes it easier to identify regional European swordsmiths, and this data can then be used with the kantei method."

Skeptical Europeans

Stefan Maeder learnt the kantei method in 1996 at the hands of the Japanese sword polisher Sasaki Takushi. He then returned to Germany to initiate a project to study the blade surfaces of European swords. He managed to overcome the hesitation of the funding organizations by arguing that swords are witnesses to the artistic handwork and technological development of their time. "Sword blades have always represented the high-point of iron and steel technology in every era."

It turned out to be more difficult, however, to obtain swords to study. Archaeologists and restorers were unwilling to part with their treasures, for they believed that the kantei method would damage them. But Maeder managed to reassure them in this respect too. "When grinding and polishing using the Japanese technique less than half a millimeter of corroded material is removed from the surface," he says. And he has yet another argument in favor of the kantei method. "There is surely no other archaeological artifact better suited to being reground than a sword blade!" He finally persuaded the National Archaeological Museum in Stuttgart to lend him three alemannic swords dating from the 6th to 8th centuries AD, which he took with him back to Japan.

New glitter on old blades

Maeder was thrilled by the texture and hardening of the alemannic swords. "The blades had a complex structure with the highest quality of handwork." The swordsmiths of yesteryear had combined steels of different qualities in one blade, hardened to different intensities and the result was a real work of art.

A roman spatha from the 4th century AD provided Maeder with the greatest surprise. This sword, the oldest European item studied so far, is made of the finest refined iron, refined meaning that the slag, charcoal and gases have been removed from the iron. In making the sword the iron was folded to create a structure consisting of innumerable layers. The more refined the iron, the more layers it is possible to create. The sword expert's analyses delivered an unexpected triumph. "Europe in early times was by no means backward in terms of the art of sword making," say Maeder. "It is therefore not true that our swords were made of poorly refined iron. Without using the kantei polishing technique it was not possible to see that European swords were made with far more than just a dozen or so layers," he adds. Exactly how many layers Japanese and European swords have is a question that Maeder wants to look into in collaboration with Empa.

Author: Daniela Wenger

Further information:

Dr. Marianne Senn, Center for Cultural Property Analytics, Phone +41 44 823 41 31,
marianne.senn@empa.ch



Sword researcher Dr. Stefan Maeder demonstrates how grinding and polishing according to the Japanese kantei method is done, on a blade dating from the early middle ages.



An alemannic blade from the 6th century, from South Germany, after treatment by the kantei method. The bright area is the hardened steel in the blade; the darker area is softer, low carbon steel.
(Photo: S. Maeder).



Metallographic microsection of a blade dating from the 3rd century BC, from La Tène. The polishing and etching process makes the metal structure visible. (Photo Empa)

Images are available from sabine.voser@empa.ch